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Choosing A High Temperature Cement

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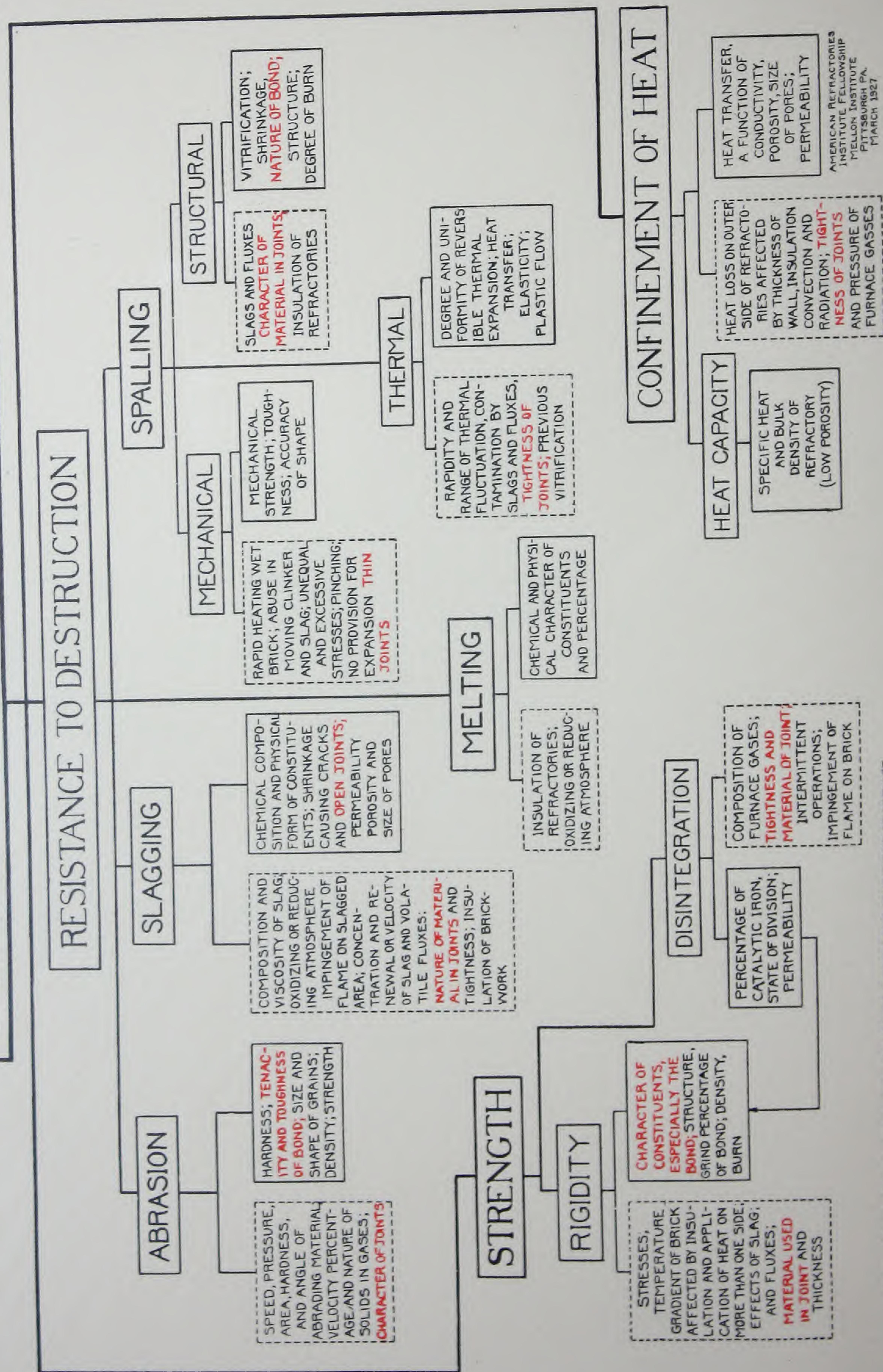
THIS booklet contains helpful information for those interested in or immediately responsible for fire brick construction and maintenance.

If you are not personally interested in furnace construction please pass this booklet on to the member of your organization who is directly concerned with the cost and service life of refractories.

*Additional copies may be had,
on request, for other interested
members of your organization.*

The importance of the joint and the bond in fire brick construction is strikingly emphasized in this chart, prepared by the American Refractories Institute Fellowship, Mellon Institute, Pittsburgh, Pa.

UTILITY OF REFRACTORIES



NOTE:- FACTORS ENCLOSED IN BROKEN BOXES REPRESENT CONDITIONS OF SERVICE.
WHILE THOSE IN SOLID BOXES REFER TO PROPERTIES OF REFRactories.

AMERICAN REFRactories
MELLON INSTITUTE FELLOWSHIP
PITTSBURGH PA.
MARCH 1927

Which High Temperature Cement?

IN many forms of fire brick construction, the proper use of a suitable high temperature cement will materially lengthen fire brick life.

Not all high temperature cements, however, are equally effective under *all* conditions. For example, a high temperature cement which is giving satisfactory service in a certain boiler furnace application may fail utterly in a metallurgical furnace where the brickwork is subject to slag attack. Another high temperature cement, used with satisfactory results in the electric melting of brass and bronze may be ineffective in the combustion chambers of a powdered fuel furnace because of the cement's susceptibility to the corrosive constituents present in fuel ash.

While the selection of a high temperature cement is of sufficient importance to warrant the

most careful consideration of the composition, advantages and shortcomings of a number of high temperature cements, *the determination of which of several cements will best meet given conditions is not a difficult task.* The common-sense application of a few, simple standards will quickly establish which high temperature cement will give most satisfactory service under your conditions.

To aid the interested user of refractories to a discriminating selection of the high temperature cement best suited to his condition is the purpose of this booklet. The observations of numerous service tests, a mass of data acquired in laboratory and field research and other material have been assembled and condensed for the information and guidance of the reader.



Choosing a High Temperature Cement

A few simple, but very important questions

LET us approach this matter of cement selection from the viewpoint of the non-technical reader.

We have a number of widely-known high temperature cements to consider, each of which can point to satisfactory performance in plants with which we are familiar.

Which of the cements in ques-

tion is best adapted, *by reason of its composition*, to give most satisfactory service under our conditions?

Let us ask a few questions concerning each of the cements in turn. By comparing and weighing the answers we can readily determine the suitability of the cements for our service conditions.

What is the basic component of the high temperature cement? Is it a neutral refractory?

Does the cement contain sodium silicate (generally employed as a binder in quick-setting cements)?

Is the cement really a *high temperature* cement?

Does it hold its bond through all temperatures?

Is the cement highly resistant to slag attack and fuel ash?

Is the cement adapted to patching and monolithic structures or does it show shrinkage under high temperatures?

What of the working qualities of the cement? Does it set very quickly?

Is it a dry cement?



**What is the basic component of
the high temperature cement?
Is it a neutral refractory?**

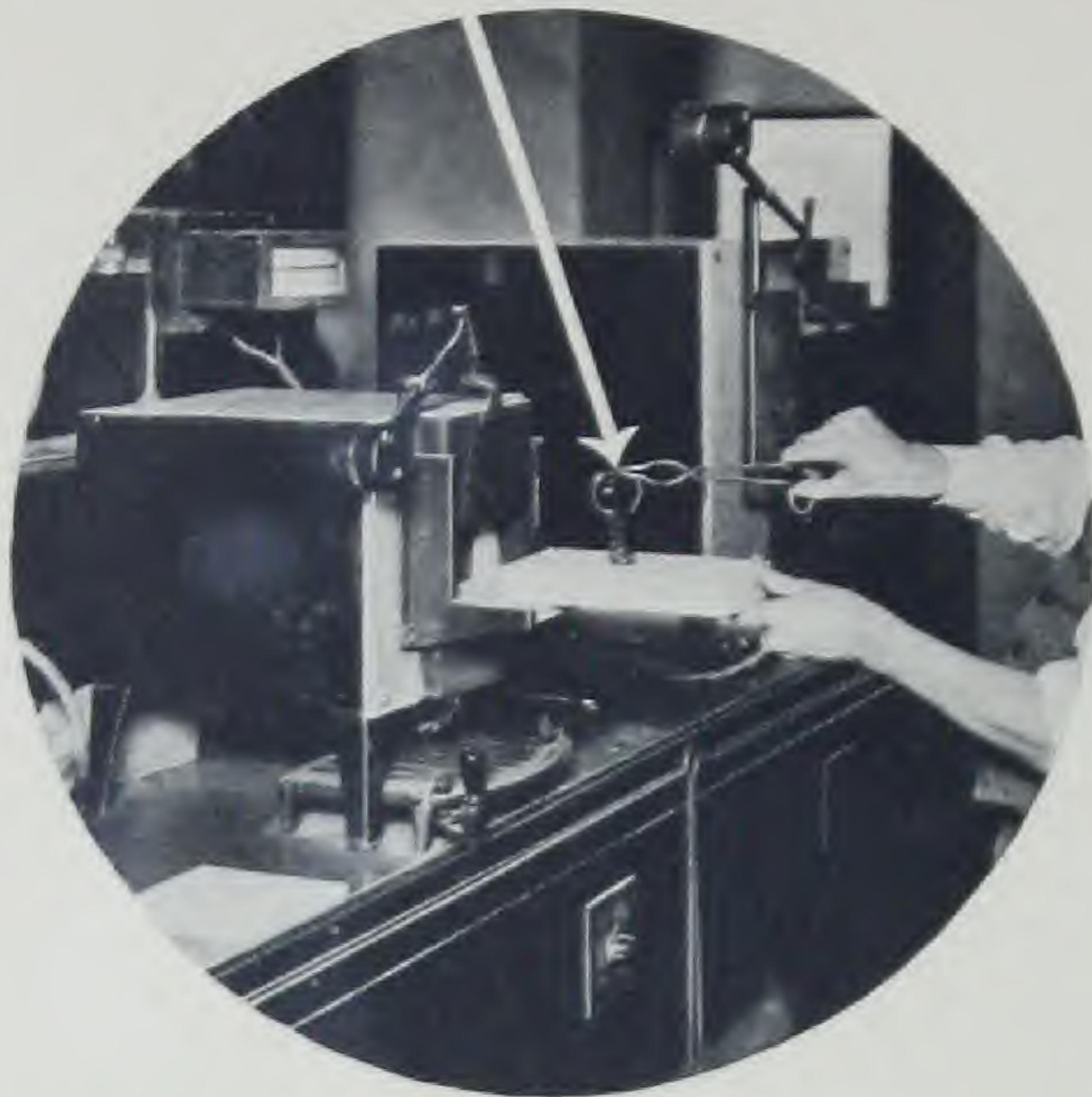


Steamer unloading chrome ore for
General Refractories Company

The Base of GREFCO is High Grade Chrome Ore, The Most Neutral of Refractories

CHROME ore is practically infusible at temperatures attained in present day furnaces. It has a softening point of approximately 3500° F. In addition to this, Chrome exhibits a resistance to slagging attack not duplicated in any other refractory. It resists various slags, fuel ashes and furnace products of either acid or basic character. Chrome is *the* chemically neutral material. Such corrosive materials as iron oxide, copper oxide, lime, alkalies, etc., which readily destroy fire clay, silica, high alumina and silicon carbide (carborundum) refractories, have but little action upon it. Chrome is the outstanding refractory for high temperature cement use.

Does the cement contain sodium silicate (generally employed as a binder in quick-setting cements)?



Crucible of sodium silicate withdrawn from furnace heated to 2000 ° F. Note that the sodium silicate has fused.

GREFCO Contains No Sodium Silicate Or Other Active Fluxes

SOUDIUM silicate is the principal bonding constituent of more than 90% of the high temperature cements, and of practically *all* the quick-setting cements.

Although employed extensively, because of its simplicity and advantages from the manufacturing standpoint, sodium silicate is by its very nature unsuited for service at high temperatures.

The name "water glass", by which sodium silicate is perhaps better known, suggests its glass-like or fusible nature. Sodium silicate is a molten glass at 2000 ° F. It is not a refractory material. (See illustration above.)

When introduced into chrome ore to make a high temperature chrome cement, sodium silicate detracts from the neutral properties of the chrome. The silicate present is readily attacked by basic oxides; it readily forms larger

amounts of fusible materials and tends to destroy the refractory.

GREFCO does not contain sodium silicate or any other active flux. *The GREFCO bond, entirely new in principle, is a development of the chemistry of colloids.* Its effectiveness results from the generation, on the surface of the chrome ore particles, of an insoluble gelatinous coating of carefully selected properties. The coating is developed by certain constituents present in GREFCO when the cement is mixed with water. This gelatinous material dries to a hard mass, *without shrinking*, and develops a strong bond upon firing to any furnace temperature. *The bonding substances used in GREFCO are not acid in nature (as is sodium silicate) and do not form fusible substances in contact with metallic oxides, slags and fuel ash.*

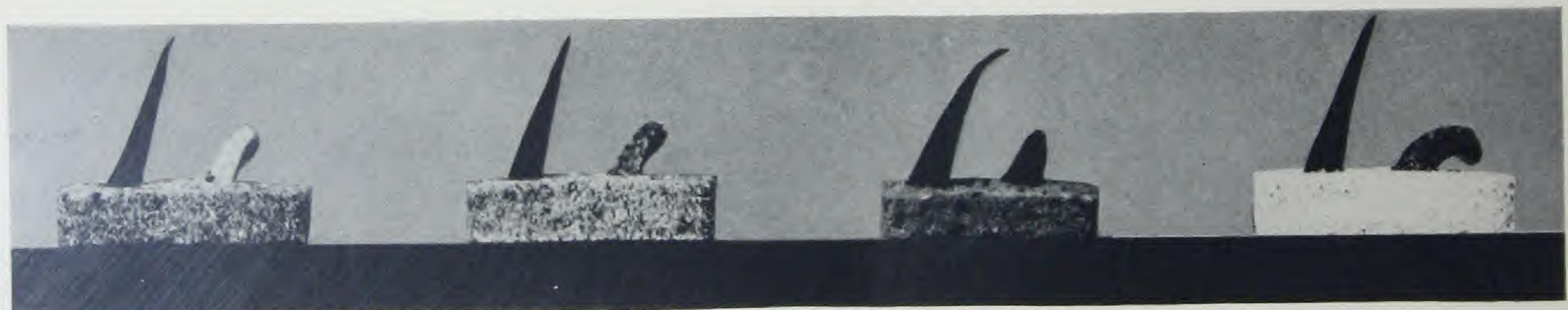
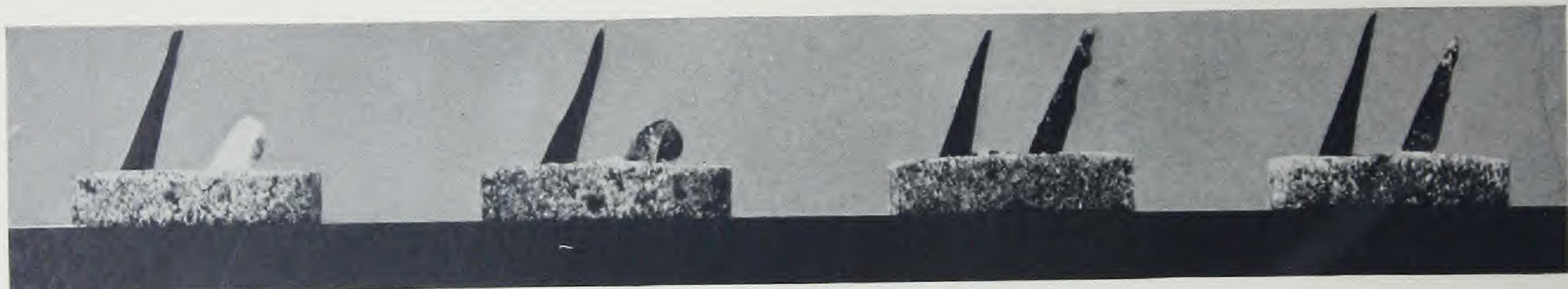
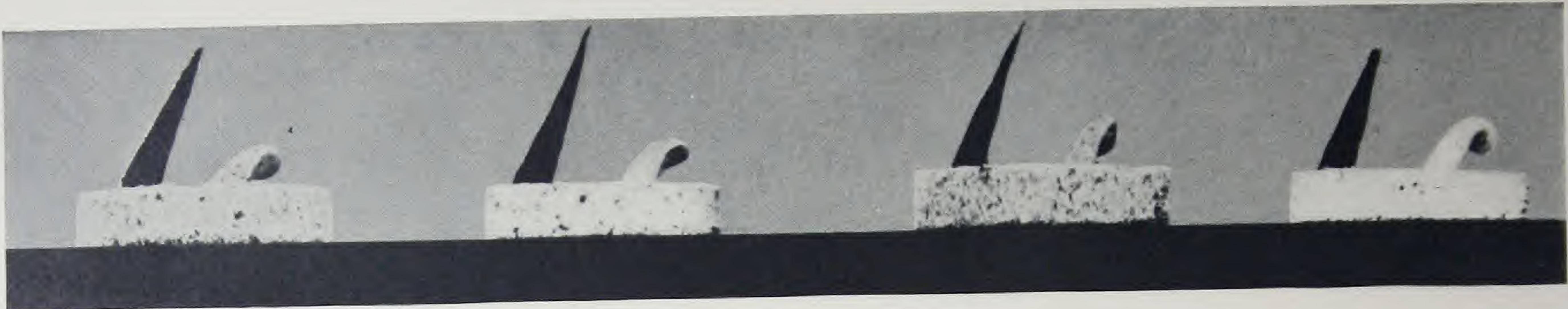
*Is the cement really a
high temperature cement?*

GREFCO is a Genuine High Temperature Cement-

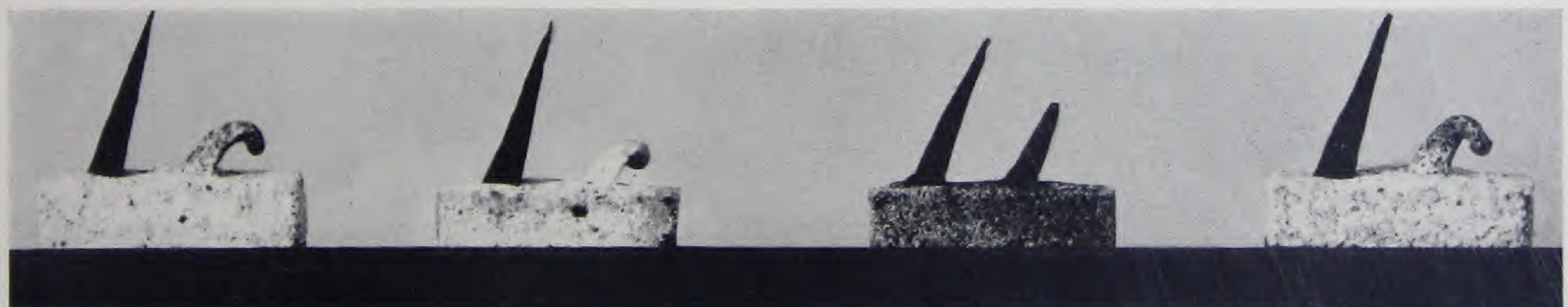
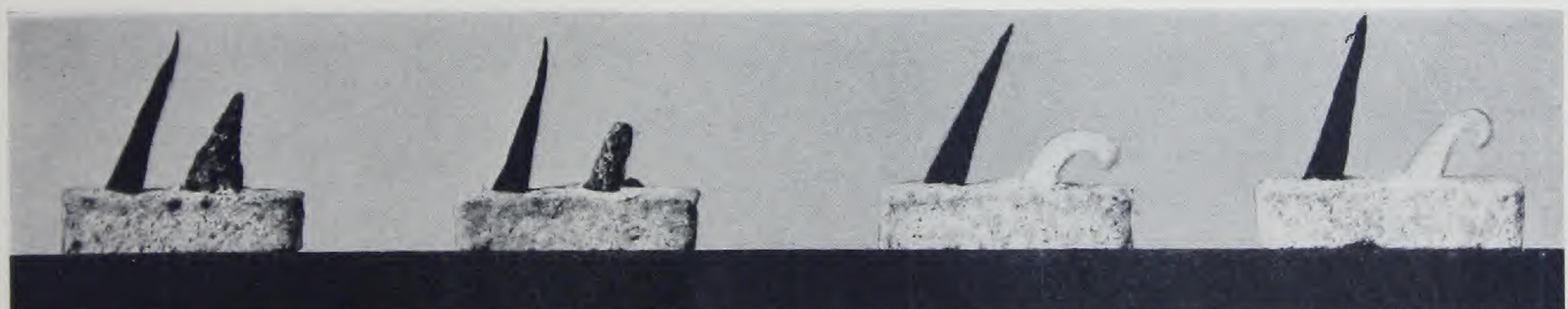
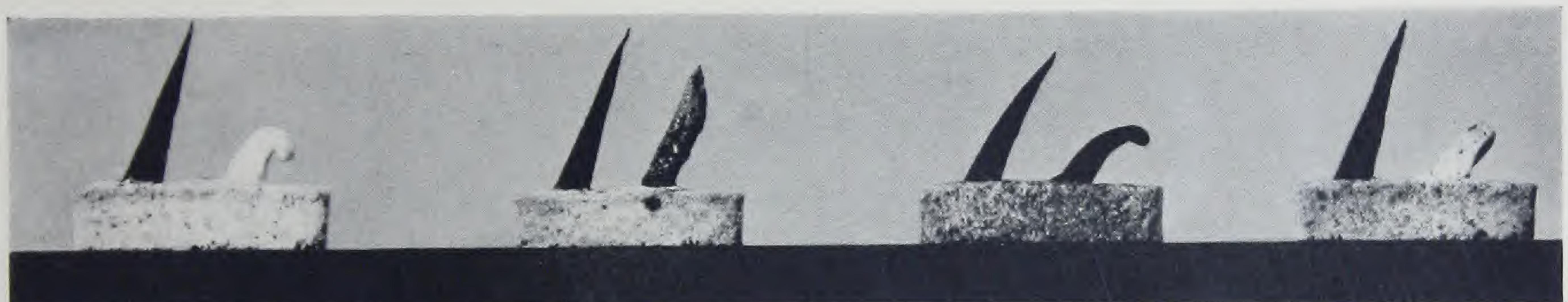
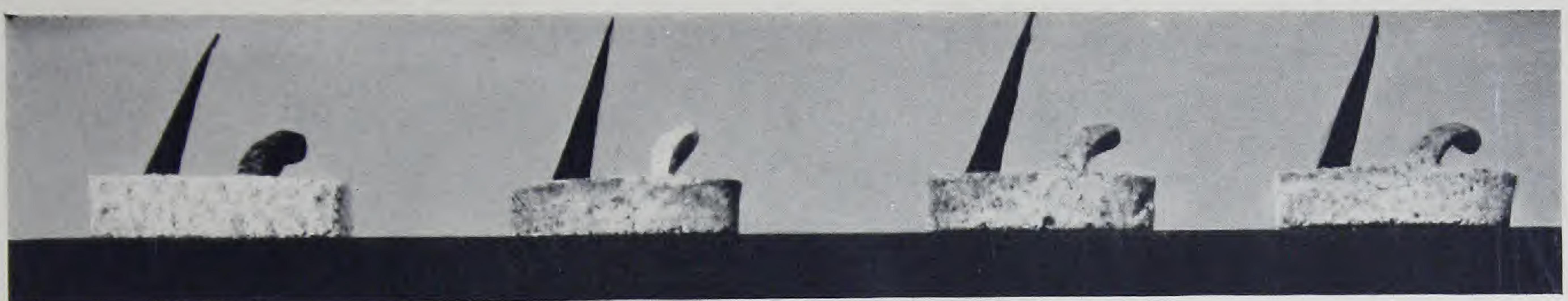
MUCH more could be said in explanation of the high refractoriness of GREFCO and the utility of a Chrome cement free of sodium silicate or other active fluxes. But, more convincing than any technical description is a comparison of the temperature-resisting qualities of GREFCO and thirty-two high temperature cements selected to include practically *every important type of cement now on the market.*

In these tests, a cone of GREFCO and a cone of another type of high temperature cement were placed on the same pat and *fired in a furnace until the other cement either fused, shrunk or started to decompose.*



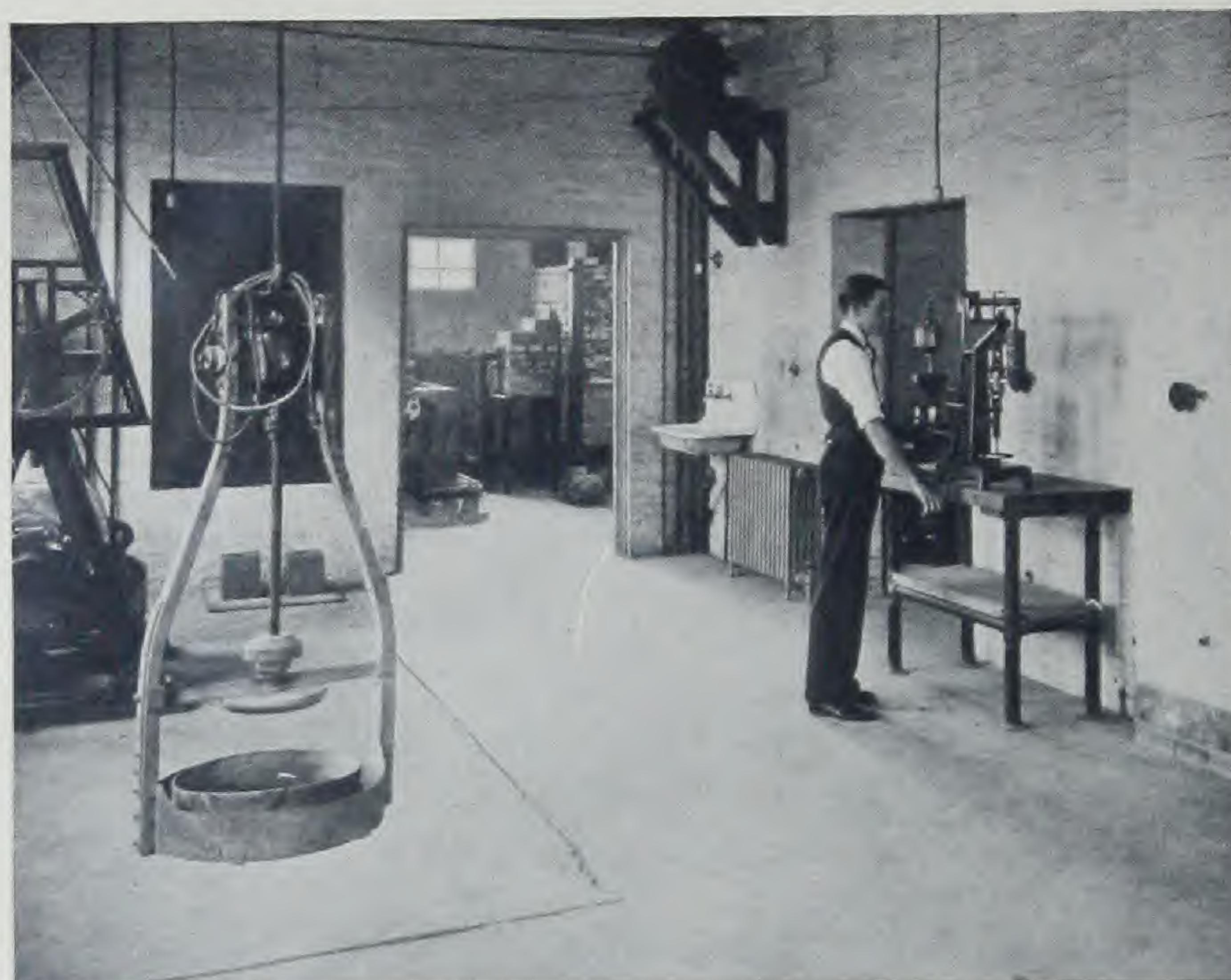


In these tests, a cone of GREFCO (left) and a cone of another type of high temperature cement were placed on the same pat and fired in a furnace until the other cement either failed, shrunk or started to decompose. In each case the cone at the left is GREFCO, (see page 7).



In these tests, a cone of GREFCO (left) and a cone of another type of high temperature cement were placed on the same pat and fired in a furnace until the other cement either failed, shrunk or started to decompose. In each case the cone at the left is GREFCO, (see page 7).

**Does it hold its bond
at all temperatures?**



Testing strength of GREFCO briquet
on standard tensile testing machine.

GREFCO Holds its Bond at all Temperatures

IN connection with high temperature cements, much stress has been laid on the strength of the initial bond. Generally, this is understood as applying to the air-setting qualities; i. e., ability to suspend brick by air-set cement, without exposure to heat.

What is really required in fire brick construction is not merely a "strong bond" in the sense that the term is used above, but more essentially *a bond that will withstand corrosion at the joint*

and will hold its bonding qualities at high temperatures.

GREFCO, which is highly resistant to corrosion attack at the joint, *has* a strong bond as the term is generally understood. Tested as a standard cement briquet, GREFCO exhibits tensile strength exceeding 325 pounds per square inch (the A. S. T. M. requirement for strength of Portland Cement, standard sand mortar) after drying or firing to any temperature.

*Is the cement highly resistant
to slag attack and fuel ash?*

GREFCO, Having a Chrome Base, Is Neutral in Character and, Therefore, Highly Resistant to Slag Attack, Metallic Oxides and Fuel Ash



Crucible of GREFCO, charged with iron oxide (Mill Scale) and fired to a temperature at which the charge became molten. Note the condition of the GREFCO crucible and the absence of penetration.

ONLY a cement which is neutral in character and therefore highly resistant to the fusion induced when foreign materials act upon a refractory will withstand slag attack, cement clinker, metallic oxides, fuel ash and other corrosive agents.

Cements of fire clay, silica, high alumina or silicon-carbide (carborundum) base, particularly those bonded with sodium silicate, are by their very nature unable to withstand the attack of slag and fuel ash.

The unretouched photographs on this and the following page illustrate the high refractoriness of GREFCO, its neutral character, and its exceptional resistance to attack by slags, fuel ash, metals and metallic oxides.





Unretouched photograph of crucible of GREFCO charged in the green state with pig iron, brought up to melting temperature and *held there*.

Note that the GREFCO has not been attacked by either the metal or the slag which formed upon the surface of the metal.



Crucible of GREFCO charged with bearing bronze (an alloy containing tin and lead). The charge was brought to a melting temperature and *held there*. Note the lack of penetration.



Crucible of GREFCO charged with red brass (an alloy of copper, tin, lead and zinc and fired to a temperature of 2300 ° F.) Note the excellent condition of the GREFCO crucible.



Crucible of GREFCO charged with pure copper and fired to a temperature of 2300 ° F. Note that the GREFCO has not been affected.

It is these qualities as well as those illustrated in the cone tests shown on pages 8, 9 and 13 which make GREFCO the ideal high temperature cement for general furnace construction.

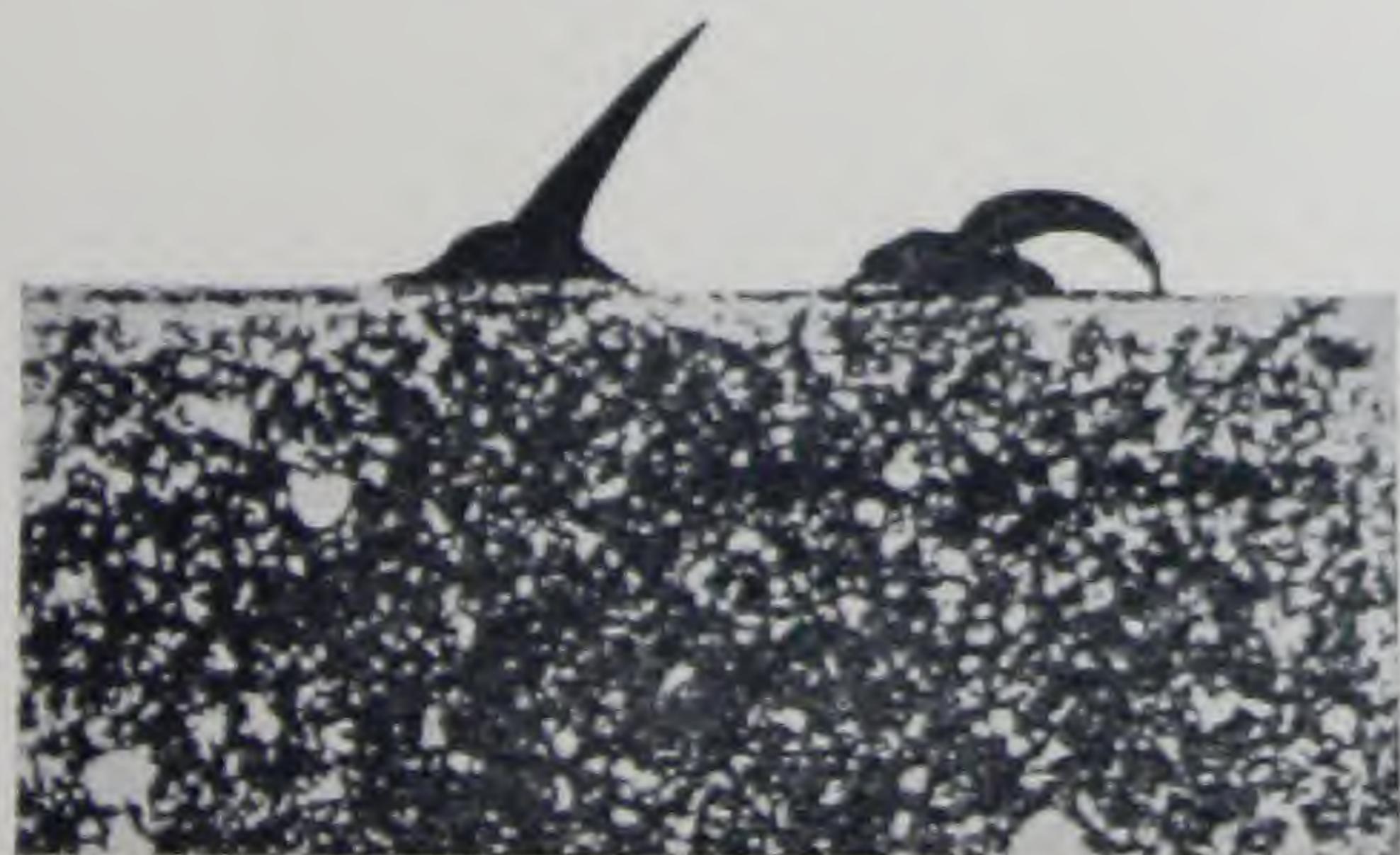
Comparative ash and slag effect tests of GREFCO and the cement which stood up best under the temperature-resisting tests of GREFCO and 32 other high temperature cements.



Cones of GREFCO (left) and other prominent high temperature cement (right), each incorporating 20 percent of low-fusing coal ash and fired at 2200 ° F. Observe the very slight effect on the GREFCO cone as compared with the decided fusing of the other cone.



Cones of GREFCO (left) and other well-known high temperature cement (right), incorporating 15 percent of basic open hearth slag and fired to 2650 ° F. GREFCO not affected; other cone, slightly fused.



Cone of GREFCO (left) and other prominent high temperature cement (right), each incorporating 15 percent of acid open hearth slag, fired to 2650 ° F. GREFCO cone only slightly affected; other cone completely fused.



Cone of GREFCO (left) and other high temperature cement (right), incorporating 15 percent of copper matte furnace slag, fired to 2650 ° F. Note that GREFCO withstood this corrosive slag while the other cement fused and softened.

GREFCO



The can is white with a red label that reads "GREFCO" at the top, followed by "HIGH TEMPERATURE CEMENT" and "IRON OXIDE".

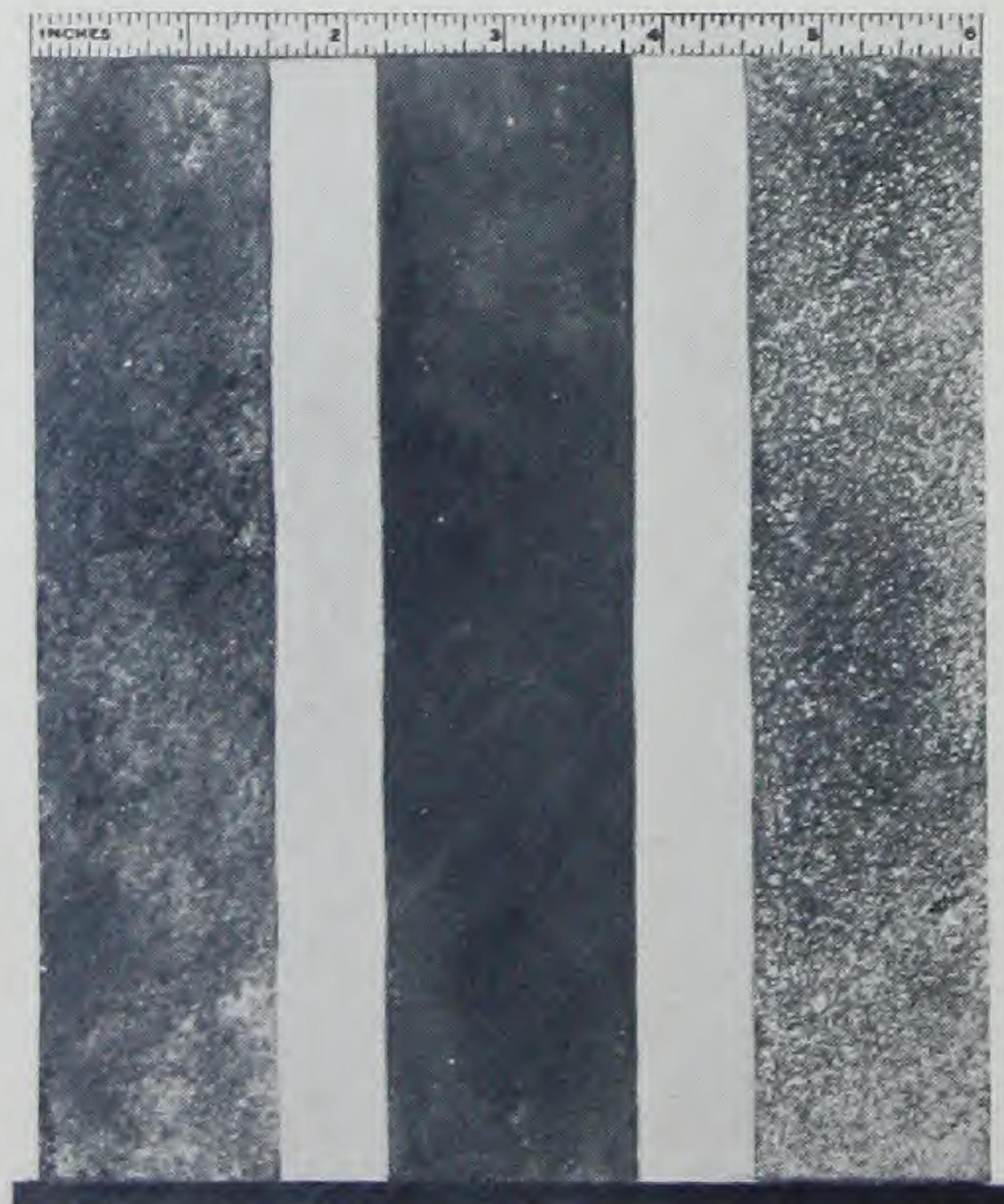
Is the cement adapted to patching and monolithic structures or does it show shrinkage under high temperatures?

GREFCO



Owing To Its Chrome Base and Its Freedom From Sodium Silicate, GREFCO Is Highly Refractory And Neutral in Character; It is Exceptionally Free From Shrinkage and is Highly Resistant to Spalling

THE high grade chrome ore used in the manufacture of GREFCO is non-shrinking (in



Bar. No. 2; fired to 1800° F.
Bar No. 3; fired to 2750° F.
Bar No. 1, not fired (for comparison).
Note there is no apparent volumetric change.

distinction to fire clay and diaspore) and does not undergo permanent expansion (in distinction to quartz, ganister, high silica clays, carborundum fire sand, etc.). With a bond properly balanced in content of plastic and non-plastic materials, GREFCO is subject to only negligible volumetric change.

GREFCO'S lack of shrinkage is graphically shown in the accompanying illustration of three GREFCO bars, two of which were fired to test shrinkage.

Actual tests upon large monoliths (50 parts GREFCO, 50 parts GREFCO-GROG, selected chrome ore ground to proper size), fired to 2750° F. for several days show total drying and firing shrinkage less than $\frac{1}{4}$ of 1%.

What of the working qualities of the cement? Does it set very quickly?

GREFCO Is Not a Quick-Setting Cement. It Can be Trowelled, Dipped and Worked As Easily as Fire Clay Mortar

BEING free of sodium silicate, GREFCO is not an air-setting cement in the sense that the term is generally applied to cements. While GREFCO sets quicker than fire clay and maintains a firm bond through all temperatures, *a quick air set has been purposely avoided.* This is an advantage appreciated by masons who object to quick-setting cements which make it impossible to lay more than a few brick to a spread of mortar and which render it difficult to line up the brick once they are set. *With GREFCO the mason can work across a long wall, dipping or trowelling and lining up the brick just as he has been accustomed to do with fire clay mortar.*

GREFCO is ready for use as soon as it is mixed with water. Its plasticity is fully developed. It is not necessary to allow it to stand 24 hours as is usually rec-

ommended for cements utilizing dry sodium silicate.

Only a small percentage of water is required to put GREFCO in its proper working consistency as compared with other cements. This is a most desirable feature in general construction and repair work as it facilitates the "drying out" operation and reduces shrinkage. This feature is particularly desirable in monolithic construction.



**GREFCO is admirably suited for application
with all types of cement guns**

GREFCO Does Not Settle in the Mortar Box

A Comparison of Five High Temperature Cements

To be suitable for dipping and easy trowelling, a high temperature cement should remain in suspension; i. e., should not settle in the mortar box.

As a comparison of the respective merits of GREFCO and

four other well-known high temperature cements with respect to their ability to remain in suspension, samples of the five cements, properly prepared were placed in glass receptacles and permitted to stand.



The above photograph was made after the cements had been standing five minutes. Note that

cements A, B, C and D have commenced to settle, while GREFCO shows no indication of settling.



The above illustration shows the same cements after standing 30 minutes. Note that GREFCO has retained its original consistency.

In actual use, cements A, B, C and D require frequent mixing, while GREFCO requires no more attention than fire clay mortar.

In connection with this comparison, it is interesting to ob-

serve the relative heat resisting characteristics of these five cements.



A B GREFCO C D
Standard cones of cements A, B, C, D,
and GREFCO and fired to 2650 ° F.

Is it a dry Cement?

GREFCO is Shipped Dry, in burlap bags It Can be Used as Needed and Will Keep Indefinitely



Two test tubes containing sodium silicate. The tube at the left has been subject to the action of carbon dioxide. Note how the sodium silicate has been decomposed by this gas into sodium carbonate, with a resultant loss of its bonding properties.

MANY high temperature cements, especially those employing sodium silicate, are shipped moist and must be kept moist, otherwise they set up and become unworkable. In addition, the buyer is required to pay for water, since most of these cements contain from 15% to 25% moisture. Dry cements containing sodium silicate must also be kept in air-tight containers to prevent the decomposition which occurs when sodium silicate is exposed to the carbon-dioxide present in the atmosphere. With such decomposition of the sodium silicate, the bonding power of the cement is destroyed and the cement becomes useless.

GREFCO is *shipped dry*, in burlap bags, 150 pounds to the bag. It will not deteriorate in storage and is not affected by the atmosphere. With only ordinary care and protection against weather damage, GREFCO *will keep indefinitely*.





Research and experimental laboratories of the General Refractories Company
Equipped with every facility for the improvement of ceramic products
and the solution of your refractory problems.

GREFCO was not produced commercially and offered to the refractory user until several years of service tests had proven its superiority.

In the development of GREFCO advantage was taken, frankly, of the pioneering work of other high temperature cements and the shortcomings and disadvantages which time had developed. Into the development of GREFCO went a great deal of thought and extensive laboratory and field work.

GREFCO

Some Suggested Applications of GREFCO

GREFCO has now been in use for two years and has conclusively proved its worth in many applications. Among the industries and applications for which GREFCO is ideally suited are the following:

BLAST FURNACE PLANTS

Furnace

For laying brick, bustle pipes and down-comers

Hot Blast Stoves

Combustion chambers; arches; hot metal mixer cars, for lining and spouts

FERROUS METAL PLANTS

Open Hearths

Ports

Bulkhead Construction and Repairs
Checker Chamber Construction and Repairs

Monolithic Tap Holes
Jamb Repairs

Puddle Furnaces

Combustion Chambers
Flues and Bridgewalls

Heating Furnaces

Combustion Chambers
Sidewalls and Roofs
also Monolithic Bottoms

Soaking Pits

Malleable Furnaces

Combustion Chambers
End and Side Walls

Electric Furnaces

Jams, Side Walls and Roofs

Annealing and Heat Treating Furnaces

Combustion Chambers and
General Construction

Forge Furnaces

As a Mortar and as a Protective Coating
and for Monolithic Construction

Mill Furnaces

Mortar and Monolithic Bottoms
Special Monolithic Burner Blocks

Welding Furnaces

As a Mortar, Protective Coating and
Monolithic Construction

NON-FERROUS METAL PLANTS

Complete Monolithic Linings in Small Direct Arc or Open Flame Type Furnaces,
Pot or Crucible Furnaces

Electric Induction Furnaces

Monolithic Construction

Smelting Furnaces

As a Laying Mixture for Brick and as a
Protective Coating

Converters

As a Mortar for Laying Brick and for
Patching Tuyeres

Zinc Retort Furnaces

For Retort Benches or Stools

Flue Linings

General Furnace Patching

BOILER PLANTS

As a Mortar and Protective Coating on All
Refractory Brick Work
Monolithic Baffle Construction

CEMENT AND LIME PLANTS

Hot Spot Patching
Hoods

Fire Boxes and Combustion Chambers
of Kilns and Dryers

OIL REFINING PLANTS

Furnace Walls and Arches

CERAMIC PLANTS

Tunnel Kilns

Bee Hive and Continuous Kilns
Flues and Stack-Breechings

GLASS PLANTS

General Tank and Lehr Furnace Construc-
tion Where Not in Contact with Glass
Flues
Ports
Checker Chambers

GAS PLANTS

Water Gas Sets

As a Mortar and Protective Coating for All
Brick Work

Coal Gas Benches

As a Mortar and for Patching

By-Product Coke Ovens

Bonding Brick Work in Combustion and
Checker Chambers

CHEMICAL PLANTS

Special Applications Such as Ammonia
Converters, Rotary Kilns and Dryers

INCINERATORS

Furnace Construction

As a Mortar and Protective Coating

If you are experiencing refractory difficulties, a line to the nearest sales office of the General Refractories Company, outlining your problems in detail, will bring you a frank statement as to whether or not GREFCO can be of service in overcoming your particular problem.

A Complete Refractory Plant

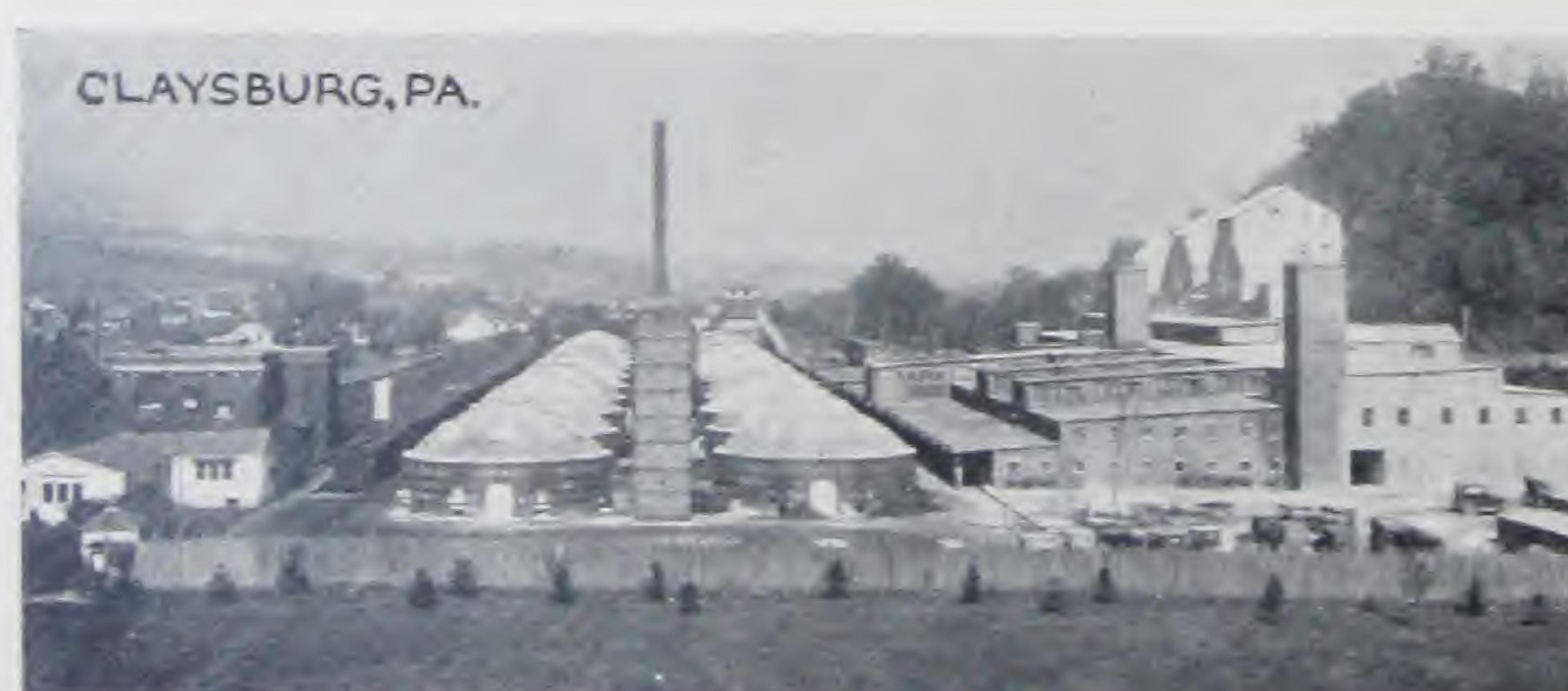
Fifteen plants with a capacity of 1,500,000 bushels per year

Fire Clay Refractories
Hand Made, Machine Made, Dry Pressed,
G. R. Co. Sizing Process and BIASBRIX

GREFCO



SANDY RIDGE, PA.



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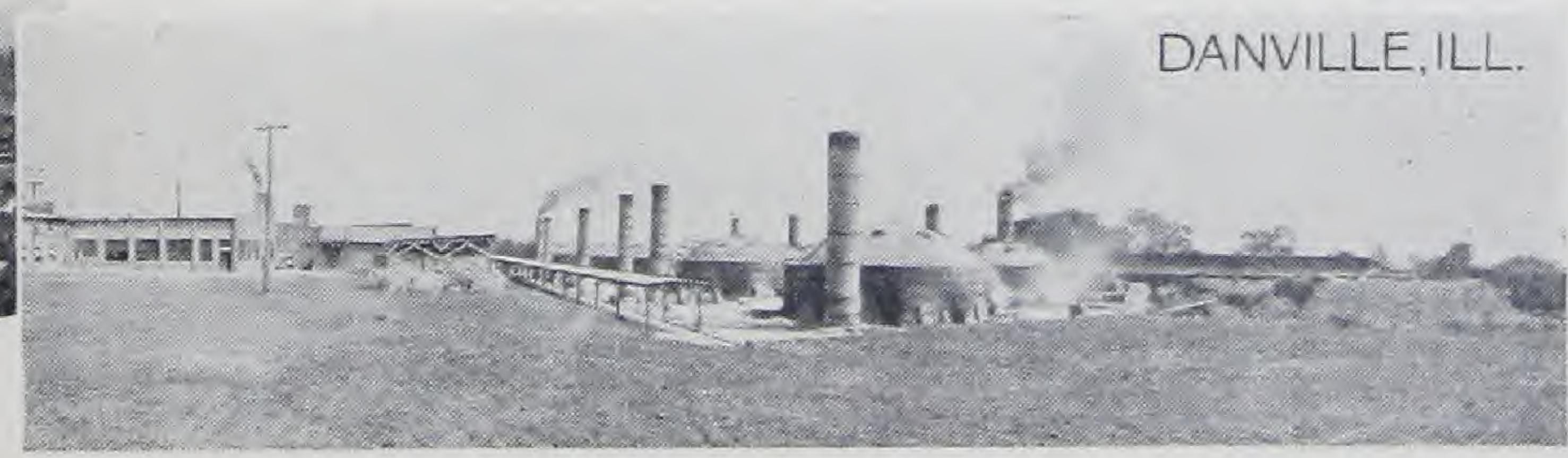
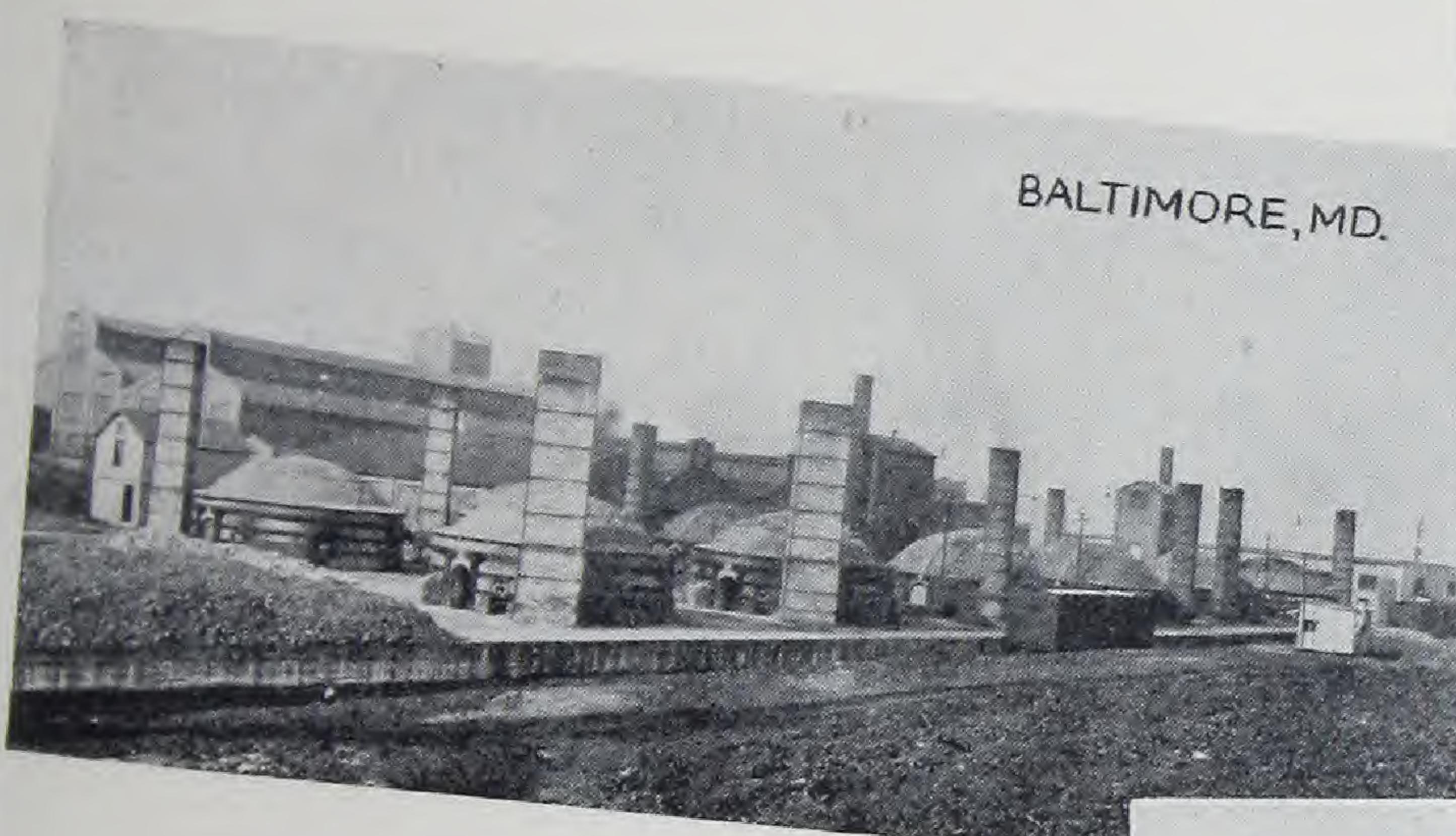
Sproul,

Joliet, Ill.

refractory Service of 1,000,000 brick per day.

**Chrome High
Temperature Cement**

Silica, Chrome, Magnesite and Diaspore
(High Alumina) Refractories
All Standard and Special Shapes



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